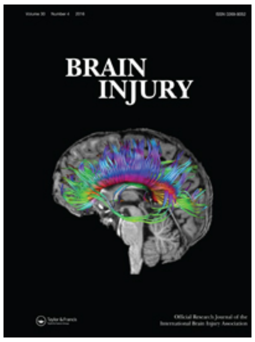

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ORIGINAL ARTICLE

Efficacy and acceptability of a home-based, family-inclusive intervention for veterans with TBI: A randomized controlled trial

Laraine Winter[1,2], Helene J. Moriarty[2,3], Keith Robinson[4,5], Catherine V. Piersol[6], Tracey Vause-Earland[6], Brian Newhart[4], Delores Blazer Iacovone[4], Nancy Hodgson[7], & Laura N. Gitlin[7]

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Abstract

Objective: Traumatic brain injury (TBI) often undermines community re-integration, impairs functioning and produces other symptoms. This study tested an innovative programme for veterans with TBI, the Veterans' In-home Programme (VIP), delivered in veterans' homes, involving a family member and targeting the environment (social and physical) to promote community re-integration, mitigate difficulty with the most troubling TBI symptoms and facilitate daily functioning.
Setting: Interviews and intervention sessions were conducted in homes or by telephone.
Participants: Eighty-one veterans with TBI at a VA polytrauma programme and a key family member.
Design: This was a 2-group randomized controlled trial. Control-group participants received usual-care enhanced by two attention-control telephone calls. Follow-up interviews occurred up to 4 months after baseline interview.
Main measures: VIP's efficacy was evaluated using measures of community re-integration, target outcomes reflecting veterans' self-identified problems and self-rated functional competence.
Results: At follow-up, VIP participants had significantly higher community re-integration scores and less difficulty managing targeted outcomes, compared to controls. Self-rated functional competence did not differ between groups. In addition, VIP's acceptability was high.
Conclusion: A home-based, family-inclusive service for veterans with TBI shows promise for improving meaningful outcomes and warrants further research and clinical application.

Keywords

Community reintegration, family, in-home service, rehabilitation, traumatic brain injury, veterans

History

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Introduction

Traumatic brain injury (TBI) has affected 300 707 service members since 2000 [1]. Medical and psychological sequelae of TBI may encompass problems with memory, concentration, organization, confusion, and judgement; limitations in physical functioning; pain; sleep disorders; tinnitus; photosensitivity; irritability, anger and emotional dysregulation; disinhibition; depression; and disturbances in behaviour and interpersonal relationships [2–8]. Moderate-to-severe TBI commonly requires a lifetime of services [1]. Some individuals with mild TBA (mTBI) also experience long-term mental and physical health consequences [8,9].

In response to TBI's emergence as a signature wound of the wars in Iraq and Afghanistan, the VA Polytrauma System of Care was implemented in 2006 as a post-acute rehabilitation service for TBI and amputee populations [4,10]. TBI has also gained increasing prominence as a public health issue in the civilian population [11]. Rising awareness of TBI in civilian and military populations has stimulated research about impairments, the natural course of recovery, measurement of function and the efficacy of interventions to remediate or manage symptoms. Several reviews have summarized findings from clinical trials of cognitive rehabilitation, psychological and psychoeducational interventions for TBI [12–15]. In an RCT with post-concussion syndrome patients, Mittenberg et al. [16] tested a brief cognitive-behavioural intervention consisting of education about symptoms, cognitive-behavioural therapy and techniques for reducing symptoms. Patients receiving the intervention showed lower symptom severity, duration and number of days with symptoms compared to controls. Backhaus et al. [17] used manualized group training in coping strategies for patients and caregivers, improving perceived self-efficacy for both. Vanderploeg et al. [18] compared two rehabilitation approaches in acute inpatients with moderate–severe TBI—cognitive-didactic vs functional-experiential—finding no consistent superiority of either approach. A motor-imagery strategy for stroke, brain, injury or multiple sclerosis was tested in an RCT by Bovend'Eerdt et al. [19], but proved difficult to

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implement and showed no difference between groups over time. Pace et al. [20] developed an interdisciplinary neurorehabiltiation intervention (e.g. physical, occupational, psychological services) in patients' homes. Although not evaluated in an RCT, it showed improvements in patient-identified therapeutic goals and patient satisfaction.

In addition, several cognitive rehabilitation approaches have been tested in controlled studies [21]. Although most targeted cognitive functioning [22–24], several examined effects on social participation or community re-integration as well [25]. Cicerone et al.'s [26] comprehensive rehabilitation intervention showed benefits for community re-integration and quality-of-life, as well as neuropsychological functioning. Some non-randomized trials of cognitive rehabilitation interventions have also shown benefits for productivity [27] (e.g. in work, school). Kreutzer et al.'s [28] non-controlled study to evaluate the impact of the Brain Injury Family Intervention for families reported more met needs for family members at post-treatment and 3-month follow-up. Many findings from this literature are reflected in best-practice guidelines for TBI that include rehabilitation practices [29–33].

Most TBI rehabilitation focuses on restoration of cognitive functioning (e.g. memory) and occurs in a clinical setting with the patient alone—features that may not produce optimal benefits for individuals with TBI. These features may under-emphasize the achievement of goals important to the veteran and neglect a source of support—the home environment, both its physical and social properties—that would help patients achieve such goals. Services for TBI seldom are delivered in the home setting, despite a strong rationale for assessment and service delivery in the environment in which the patient must function [20,28,34]. Research targeting families has also been under-represented. Abundant evidence documents family involvement, the value of their care and their high levels of distress and unmet needs [34–38]. Only a few methodologically vigorous studies have tested family-focused interventions [39]. In addition, few evidence-based practice models have been identified for veterans with mild-to-moderate TBI [40–42], even though these constitute the majority of military and civilian TBI cases [1,11]. In addition, the scarcity of methodologically vigorous research leaves a gap in evidence for TBI interventions. Because patients with TBI may improve over time, pre–post designs make it difficult to attribute observed improvement to treatment, underscoring the need for randomized controlled trials.

The Veteran's In-home Program (VIP)

The VIP aims to minimize dysfunction and improve well-being by targeting the environment for intervention. In contrast with rehabilitation approaches that focus on restoring cognitive functioning (i.e. retraining the brain), VIP tailors environmental changes and compensatory strategies to the difficulties each veteran identifies as most troubling, occurs in the home and solicits family involvement. The role of the home environment in everyday function and well-being has a long tradition, but is neglected with persons with TBI. Lewin's [43] person-environment fit concept introduced the interaction between personal competence and environmental press and the importance of this fit to individual well-being. Environmental press refers to the demands from the environment that support or challenge performance of daily activities. A good fit between the person's competence and environmental press results in optimal outcomes—positive affect and adaptive behaviour. When an individual's competence is impaired, the range of acceptable environmental press becomes narrower. Negative affect and maladaptive behaviour result when environmental press is too great. Because environment forces may support or create a barrier to positive outcomes, press imposed by the environment should be targeted for intervention. Common TBI symptoms such as difficulties with cognitive function and emotion regulation can undermine the competence required to deal with everyday demands such as children making noise or work obligations. Similarly, driving a car may impose environmental press for an individual with TBI who is prone to road rage; academic demands are a challenge for a person having difficulty with memory or organizing study materials.

The VIP extends previous work with dementia caregivers and frail elders using the person-environmental fit approach [44–50], adapting it for TBI-specific problems such as memory loss, executive dysfunction, emotional and interpersonal problems and sensory problems like tinnitus and photosensitivity. It less commonly addresses physical losses (e.g. problems with dressing)—problems more common with dementia or frailty. In contrast, strategies for enhancing memory may be useful in both dementia and TBI. Common to all is the use of a tailored approach and the goal of enhancing person-environment fit by creating conditions that enable people to complete meaningful tasks and attain goals.

By identifying the environmental characteristics that impact functioning, the interventionist works together with the veteran to identify strategies that will reduce environmental stress and promote competence. For example, losing keys and other important items, a common problem with impaired memory and organization, often leads to frustration and irritation or anger, with unpleasant consequences for the family. Such problems may be minimized by modifying the environment and creating compensatory strategies, mitigating several negative outcomes. Table I presents sample TBI-related problems that illustrate the complex inter-relationships among cognitive, interpersonal, emotional and physical domains of functioning that a problem may represent.

VIP focuses on the veteran and a family member actively involved in the veteran's daily life, selected by the veteran him/herself, who was brought into the intervention as much as possible. The inclusion of family in the intervention process reinforces intervention strategies, keeps the family informed and addresses their needs. Their inclusion is facilitated by VIP's in-home setting, since few family members can attend daytime clinic appointments with veterans. Delivery of the intervention in the home, where dysfunction is likely to occur, also provides ideal opportunities to interact with the veteran and family in their natural environment, observe their functioning, assess the home environment and identify relational issues often not evident in an outpatient clinic visit. VIP, therefore, consists of (1) in-home clinician assessments of functioning using standardized tools, (2) identification of the problems that the veteran wishes to work on, leading to an Action Plan, (3) development of strategies to modify the physical and/or psychosocial

Table I. Selected examples of TBI-related problems identified by veterans and addressed in VIP action plans.

Problem examples	Examples of intervention strategies
Losing keys and other items leading to frustration, irritation, family upset	Create a control centre near the front door, bedroom or both; control centre re-organized on a weekly basis
Missing appointments and deadlines, leading to problems with school, work and healthcare utilization	Training with iPhone apps for appointment calendar, use of reminder alarms, notes for recording lists and other important information, apps to communicate and share information with family member
Over-stimulation from normal home noise level, producing irritation, withdrawal from family interactions	Explaining to family member veteran's need to remove self from noise; rule out hearing loss
Difficulty with socializing, leading to embarrassment and social isolation	Start with smaller groups, smaller venues; invite fewer people to gatherings at home
Irritation with driving practices of others, leading to road rage and unsafe driving	Preparation for driving with relaxation exercise; use of soothing music in car
Academic difficulties (poor study habits; limited activity endurance)	Organization of work space; pacing study activities; use of organization materials and strategies (e.g. colour coding; completing school work in a quiet room at a time of day when children are at school; organization of work/self-care space to facilitate ease and decrease frustration)
Limited leisure activity/social isolation	Physical fitness activity (e.g. joining a gym/health club; linking up with VA organization; walking the dog)
Decreased household management	Use of whiteboard in kitchen to record assignment of the day; use of dining room space for visual cuing of tasks

environment and tasks, to mitigate each identified problem, developed with the participation and support of a key family member whenever possible.

Designed as a value-added component of the polytrauma programme of the VA Medical Center at Philadelphia Polytrauma Service, VIP was designed to address the complex problems of everyday living posed by TBI, developing strategies that compensate for impairments and are tailored to each veteran's context and self-identified concerns. This evaluation study addresses the need for evidence-based research on interventions to manage TBI-related problems and deficits. Its 2-group randomized controlled design allows changes to be attributed to the intervention, rather than natural recovery from TBI. The study also employed measures widely recognized as meaningful outcomes—community re-integration, difficulty managing patient-identified TBI problems and self-rated functioning.

Method

Design

The study was a two-group randomized controlled trial. Veteran-family member dyads were randomly assigned to either VIP or a usual-care control condition. Participants were stratified by veteran's gender and randomized within one of two strata using random permuted blocks, which controls for possible changes in subject mix over time. The blocking number was developed by a statistician and unknown to others. Randomization lists and forms were prepared using opaque envelopes. A principal investigator randomized each dyad within 48 hours of baseline interview. An intention to treat model was followed, using data from all participants, even if they dropped out of the intervention.

Intervention

VIP provided up to eight contacts, six in-home health professional visits of 1–2 hours duration each and two telephone contacts. Four months was considered the optimal time to establish rapport and collaboration and build skills [46–50]. A 3-phase intervention followed a model used in previous studies by investigators. In Phase I (assessment; contacts 1–2), the occupational therapist meets with the veteran and family member together, unless otherwise requested, to identify concerns of each, review intervention goals and administer an occupational performance assessment of cognitive functioning [51–54] to the veteran. In Phase II (contacts 3–7), problems are identified through discussion with the veteran, and the interventionist introduces strategies for each (see Table I examples). An Action Plan, documenting targeted activities, goals and strategies, is developed for each patient-identified problem and is referred to throughout the intervention [46–50]. Veterans identified a mean of 3.5 problems (range = 1–7) in their Action Plans. For home modification, special equipment or assistive devices (e.g. memory aids), the interventionist arranges for their delivery, installation and training in their use. In Phase III (closure, final in-home visit), strategies are reviewed, practiced, and generalized to emerging and potential concerns. Table II presents detailed descriptions of each session.

Control condition

The control condition consisted of standard TBI care offered at the VA clinic (physiatry social work, PT, OT, speech, psychiatry, neuropsychological evaluation, and psychotherapy—available to all study participants), augmented by two telephone calls to maintain contact with participants. The telephone calls took an average of 14.3 minutes (SD = 6.85) and concerned any changes that might have occurred, the well-being of veteran and family and reminders about follow-up interviews [46].

Participants

Participants were 81 veterans with a TBI diagnosis, recruited from the medical rehabilitation service. The VA automatically

Table II. Session-by-session description of VIP.

Session #	Location	Who present?	Activities
1	Home	Veteran & family	Introduce & provide overview of intervention: Manage problems with memory, organization, planning, or emotional functioning Remain independent in activities of daily living Make the home safer Use stress reduction techniques ☐ Discuss with veteran & family member what to expect at various stages of intervention. ☐ Provide overview of session goals ☐ Establish rapport with veteran and family ☐ Conduct clinical interview (review family's daily routines, preferences, veteran's interests) Confirm and discuss family constellation. ☐ Begin assessment of veteran (complementing prior OT assessments if one in clinic): COPM [45], ACLS-5 [43,46.47], TCA [44] ☐ Provide information and education materials about TBI and PTSD to veteran and family; Inform him/her of the protracted nature of TBI & PTSD. ☐ Obtain closure; review plan for next session ☐ Homework: *The Pie of Life*
2	Home	Veteran & Family	*Family*: ☐ Help the family understand the experience of recovery from the veteran's perspective ☐ Family concerns ☐ Observe family's communication and interaction style ☐ Introduce and practice stress and emotional management techniques with family *Veteran*: ☐ Complete assessments with veteran ☐ Conduct Allen Diagnostic Module 2 ☐ Leisure Interests *Veteran and family member*: ☐ Introduce stress reduction techniques with veteran and family ☐ Obtain closure; review plan for next session ☐ Homework: Practice stress reduction techniques
3	Home	Family member	☐ Provide overview of session goals ☐ Assess safety of home and elements of environment related to problem areas and strategies implemented. Assess elements of environment that daily function and ability to navigate easily and safely through the home ☐ Reinforce stress management techniques with family member. ☐ Identify and practice additional coping strategies to help family member take care of self ☐ Review assessment results with veteran and family. ☐ Begin problem-solving process (ABC) and develop 1st action plan based on identified areas of need for veteran and family member and informed by clinical information. ☐ Probe for additional problems ☐ Instruct family on specific communication approaches to support Veteran's interpersonal skills and prevent emotional upset ☐ Veteran/family training may include: management strategies of behavioural & personality changes, task simplification, specific strategies reflecting modifications to the physical environment (home safety, adaptive equipment, de-cluttering, memory aids, external cues, other cognitive strategies) ☐ Summarize main session points; plan for next session
4	Phone	Veteran	☐ Describe purpose of telephone contact ☐ Review identified problems & reinforce use of strategies developed in action plan; clarify action plan ☐ Validate veteran's actions in dealing with emotions & feelings ☐ Review the use of stress management techniques ☐ Reinforce integration of strategies into daily routines
5	Home	Veteran & family if possible	☐ Provide overview of session goals with veteran and family member. ☐ Reinforce stress management and coping techniques with family member ☐ Review progress in strategy use ☐ Reinforce and practice use of specific strategies ☐ Problem solve if unable to implement action plan and modify strategies as necessary ☐ Develop and practice 2nd action plan ☐ Discuss generalization of strategies to other contexts (e.g. within family, work, other community activities) ☐ Summarize main session points; plan for next session

(*Continued*)

Table II. (Continued).

Session #	Location	Who present?	Activities
6	Home	Family member	☐ Review progress and reinforce strategy use with family member ☐ Reinforce and practice use of strategies ☐ Determine what was effective and modify strategies if necessary ☐ Discuss generalization of strategies to other contexts (e.g. within family, work, other community activities) ☐ If relevant, introduce 3rd action plan ☐ Provide recommendations for veteran's activity participation & community re-integration ☐ Summarize main session points; plan for next session
7	Phone	Veteran	☐ Review progress; clarify action plan(s) ☐ Reinforce use of strategies
8	Home	Veteran & family member	☐ Reassess COPM pre–post test ☐ Review all strategies and techniques used to address stated problem areas ☐ Discuss generalization to future circumstances ☐ Obtain closure ☐ Complete Readiness to Change Scale (for veteran and family member)

screens all post-9/11 veterans for TBI and veterans from previous war cohorts, although not routinely screened, may be referred for TBI evaluation through primary-care and psychiatry providers. Medical rehabilitation service patients who screened positive on the initial TBI screen or the secondary TBI evaluation were sent an IRB-approved letter of invitation. The letters were followed up with a telephone call, which confirmed the veteran's eligibility for the study, answered questions and elicited the veteran's willingness to participate. Inclusion criteria comprised being post-deployment from the Vietnam War era to the present; able to speak English; meeting VHA Polytrauma Systems of Care criteria for TBI; and having a family member or partner actively involved in his/her life, living with him/her or within 30 minutes transportation time. In addition, the severity of TBI diagnosis for each selected participant was confirmed by the medical director of the medical rehabilitation service at the VA Medical Center at Philadelphia (a rehabilitation physician with expertise in polytrauma and TBI). Appendix A provides a detailed description of the diagnostic criteria. The exclusion criterion for veterans was high risk for violence, as judged by the medical rehabilitation service clinical team. The study was approved by the Institutional Review Board of the VA Medical Center at Philadelphia.

Measures

Sociodemographic characteristics

These data included gender, age, race, Hispanic ethnicity, years of formal education, marital status, number of children, number of children living at home, religion and financial well-being ('How difficult is it to pay for basics like food, housing and medical care?' [55]). The response format for financial well-being was a 4-point Likert scale, from 0 (not at all) to 3 (very).

Military and medical characteristics

To define TBI severity, a study co-investigator with expertise in rehabilitation medicine reviewed each veteran's electronic medical record and determined the severity level of the most recent TBI based on the VA/DOD Guidelines (see Appendix A). A review of the Computerized Patient Record System (CPRS) by the principal investigators yielded information about each veteran's war cohort, number and source of TBIs, years since most recent TBI and co-morbid conditions (PTSD, depression, tinnitus, photosensitivity and pain).

Depressive symptomatology

This was measured using the short form of the Centre for Epidemiologic Studies Depression Scale (CES-D) [56], a well-established 10-item screening instrument. Assessing the frequency of each symptom in the past week, the response format for each item ranges from 0 (never or rarely) to 3 (every day). The possible range is 0–30, with higher scores representing greater depressive symptomatology. A cut-off score of 10 or higher indicates the presence of significant depressive symptoms. Reliability and validity of the CES-D short form are well-established [32]. Cronbach's alpha for the present sample was 0.85.

Community re-integration

Widely recognized as the core goal of rehabilitation for TBI, community re-integration has been conceptualized and operationally defined in various ways [57–61]. The Community Re-integration for Service Members scale (CRIS) [62], which was developed for military samples, is a 147-item multidimensional instrument that includes measures of extent and satisfaction with social participation and health and physical functioning. Because health and physical functioning were also measured with other study tools (see below), in order to minimize construct confusion, redundancy and research burden, this study selected Extent of Participation as the core construct of community re-integration. This construct also has been viewed as the most objective measure of social participation [63]. These 12 items concern participation in activities with family, friends and the community. Veterans indicated how often they did or experienced certain activities within the past 2 weeks, using response formats from

1 (not at all) to 6 (always). Three additional questions captured participation in work (using a 0–3 response format) and school (using a 1–3 response format) and having a friend in whom to confide (answered yes or no). Appendix B presents the brief version of the CRIS used in the present study. Because different response formats were used, responses were *z*-scored. The *z* scores were used in place of raw scores to compute Cronbach's alpha and in the ANCOVA for community re-integration. Cronbach's alpha for this measure using this sample was 0.71.

Patient competency in functioning

The Patient Competency Rating Scale [64–66] is a standardized 30-item measure of patient functioning used extensively with TBI populations. Patients rate their competency in cognitive, emotional/interpersonal and physical functioning in the past month. The stem question is worded, 'How much of a problem have you had (in the past month) in ...?', each followed by a 5-point Likert Scale (1 = cannot do; 2 = very difficult to do; 3 = can do with some difficulty; 4 = fairly easy to do; 5 = can do with ease). The PCRS has demonstrated good internal consistency and predictive validity [64–66]. In this sample, Cronbach's alpha was 0.92.

Target outcomes

Target outcomes are a patient-centred index of everyday problems related to the patient's medical condition. They have the advantage of representing the most troublesome problems caused by the TBI, as reported by veterans in their own words [47,48,67]. After identifying each problem, the veteran is asked how difficult it is to manage the problem, using a Likert scale from 0 (not at all difficult) to 4 (extremely difficult). At the follow-up interview, a blinded interviewer enquired about each of the three problems identified by the veteran at baseline and asked, for each, whether the problem still existed and, if so, how difficult it was to manage within the last month.

Acceptability of VIP

This was operationally defined in three ways:

(1) Acceptability Scale. For veterans who participated in the VIP, its acceptability was assessed using an 18-item paper and pencil measure. This was completed by the interventionist during the final session of each veteran's intervention. Responses to each item used 5-point Likert scales, with higher scores indicating a more positive response. This scale has been used to assess acceptability of similar interventions in previous psychosocial research and has demonstrated good reliability and validity [46,50]. Cronbach's alpha was 0.94.
(2) Number of sessions attended/number of possible sessions.
(3) Willingness to participate in a future study of TBI, asked at the conclusion of the follow-up interview.

OT clinical assessment tools for veterans randomized to intervention

Three assessments tools were used in sessions 1 and 2 with the veteran, to guide development of their tailored intervention (Table I).

Procedure

The study took place from 15 November 2011 to 31 July 2014. Informed consent was obtained at the baseline interview. Veterans and family members were interviewed in their homes on the same day, with interviews conducted separately to maintain independent responses. Within 48 hours after the baseline interview, the participant was randomly assigned to VIP or a usual-care control condition. The VIP dyads were offered the VIP; the control-group dyads were contacted by telephone twice. Usual care at the medical rehabilitation service was available to both groups.

The follow-up interview, up to 4 months after baseline interview, was conducted by an interviewer blinded to participants' experimental condition. Veterans and family members were interviewed either by telephone or at home.

Data analysis

Underlying factors of competency ratings

The PCRS measures functional competency in three domains. Because use of the full unitary scale alone could obscure potentially important differences between domains of functioning, factor analysis was performed to identify underlying factors for the present sample. This principal components analysis with varimax rotation was performed on the 30 PCRS items using the veterans' baseline data, revealing three factors corresponding to social/emotional, cognitive and physical competency. Two items ('starting conversations in a group' and 'controlling laughter') loaded less than 0.40 on any factor and were, therefore, dropped. One item, 'remembering names of people I see often', did not load with cognition, as a factor, but with physical functioning. The three domains demonstrated good internal consistency: Cronbach's alpha was 0.87 for interpersonal/emotional, 0.84 for cognitive and 0.81 for physical functioning. Table III presents the items, their factor loadings and each factor's Eigenvalues. Three sub-scales were defined and means of each were used in subsequent analyses, in addition to the mean for the overall scale.

Identification of covariates

Because associations with PTSD, injury severity, years since injury and depressive symptomatology were of particular interest (in light of the prevalence of PTSD and depressive symptoms and the wide range of years since injury and severity), all were included as covariates in the analyses of covariance (ANCOVA). Veterans' gender, as a design variable, was also included. Associations of each of the outcomes with sociodemographic variables were tested using Pearson product-moment correlations or independent *t*-tests, as appropriate. No associations were found between any outcome variable and any sociodemographic variable. Thus, the covariates used in the ANCOVA models were PTSD diagnosis, TBI severity, years since most recent TBI, CES-D scores and sex.

Intervention effects on main outcomes

ANCOVAs were conducted on community re-integration, the three functional competence domains and the overall

Table III. Factor loadings of the veterans' Patient Competence Rating Scale (PCRS) items.

	Factor loading	Eigenvalue
Emotional/interpersonal		9.405
Accepting criticism from other people	0.383	
Keeping from being depressed	0.685	
Keeping my emotions from affecting ability to go about the day's activities	0.671	
Showing affection to people	0.635	
Recognizing when something I/he/she said or did has upset someone else	0.622	
Handling arguments with people I know well	0.607	
Controlling temper when something upsets me/him/her	0.581	
Getting help when confused	0.548	
Acting appropriately when around friends	0.522	
Participating in group activities	0.467	
Adjusting to unexpected changes	0.529	
Controlling crying	0.431	
Cognitive		2.202
Remembering my daily schedule	0.727	
Scheduling daily activities	0.710	
Remembering important things I must do	0.657	
Keeping appointments on time	0.676	
Remember what I had for dinner last night	0.552	
Consistently meeting daily responsibilities	0.572	
Understanding new instructions	0.536	
Taking care of finances	0.518	
Physical		1.924
Doing laundry	0.786	
Taking care of personal hygiene	0.773	
Washing dishes	0.759	
Dressing self	0.653	
Preparing own meals	0.563	
Driving a car if I had to	0.514	
Staying involved in work activities even when bored or tired	0.435	
Remembering names of people I see often	0.430	
Items not loading on any factor		
Starting conversations in a group		
Controlling laughter		

functional competence measure (PCRS). A multiple ANCOVA (MANCOVA) was performed on difficulty ratings for the three target outcomes. In each analysis, treatment assignment was the independent variable and PTSD, injury severity (coded mild or moderate–severe), sex, years since injury, depressive symptomatology (CES-D scores) and baseline values of each outcome variable served as covariates.

Treatment fidelity

To insure that intervention delivery was faithful to the VIP protocol, interventionists and PIs held debriefing meetings every 3 weeks. In addition, 8% of intervention sessions were attended by a principal investigator. Concerns about possible drift from the protocols were discussed and resolved at debriefings.

Results

Characteristics of sample

Of the 110 veterans screened by telephone, 86 were enrolled, as the Consort statement (Figure 1) indicates, but two veterans were not randomized and three others were later determined to have PTSD or a brain injury, rather than TBI. Thus, data from these five were dropped for the present analyses. Forty-one were randomized to intervention (VIP) and 40 to control condition. The final sample at follow-up interview was 36 in the intervention group and 35 in the control group, representing 87.7% follow-up. The most common reasons for attrition were the inability to locate the participant and participant refusal. No differences existed in completion of follow-up interview between treatment (87.8%) and control condition veterans (87.5%; Chi-square [1] = 0.002, $p = 0.967$).

Table IV presents sociodemographic characteristics of the veterans with TBI. Veterans had a mean age of ~ 40 years, most were male and White and nearly one-third Black. Most family members were spouses or partners. Only about one-third of veterans were employed, compared to nearly two-thirds of family members.

Table V presents medical and military information about TBI severity, veterans' war cohort, source of TBI, number of TBI incidents, psychiatric comorbidities (PTSD and depression), time since first TBI and most recent TBI and common comorbidities. Most TBIs were mild. Of particular note, the mean time since the most recent TBI injury was nearly 10 years, ranging from 1–45 years (for a Vietnam War veteran). However, the TBI evaluation and diagnosis were recently obtained. This reflects the many long-standing TBIs that have only recently been diagnosed, a result of increased awareness of TBI by healthcare providers and the

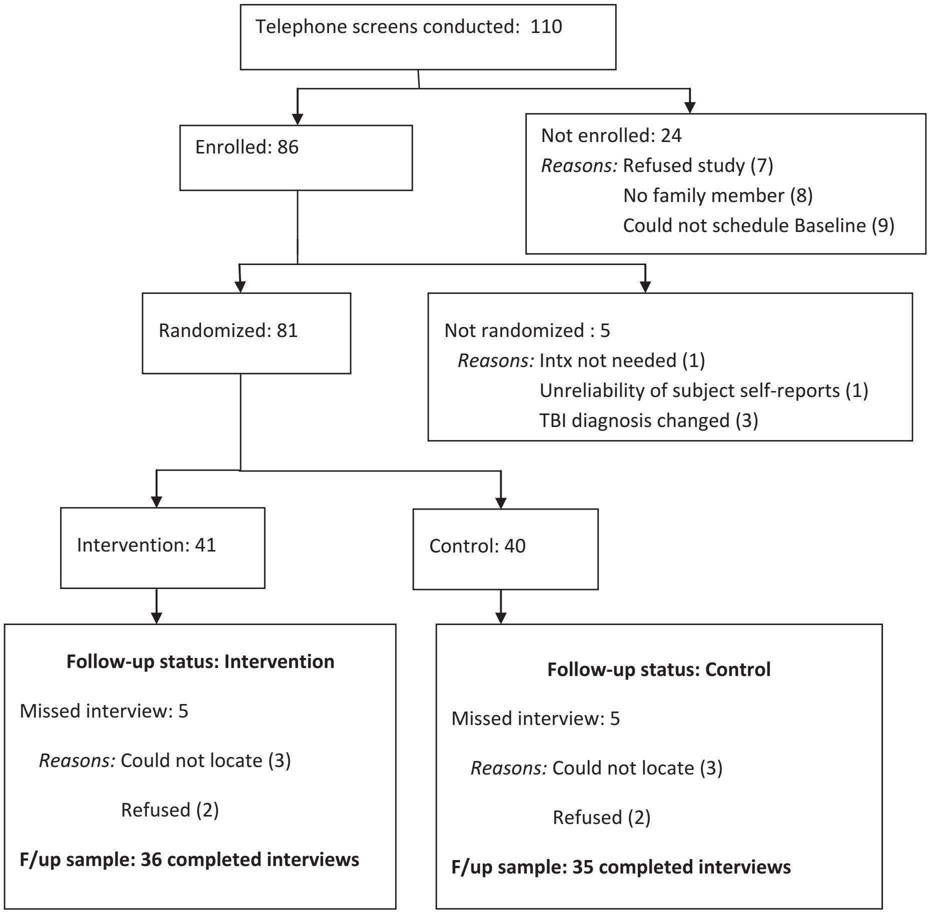
Telephone screens conducted: 110
Enrolled: 86
Not enrolled: 24
Reasons: Refused study (7)
No family member (8)
Could not schedule Baseline (9)
Randomized: 81
Not randomized : 5
Reasons: Intx not needed (1)
Unreliability of subject self-reports (1)
TBI diagnosis changed (3)
Intervention: 41
Control: 40
Follow-up status: Intervention
Missed interview: 5
Reasons: Could not locate (3)
Refused (2)
F/up sample: 36 completed interviews
Follow-up status: Control
Missed interview: 5
Reasons: Could not locate (3)
Refused (2)
F/up sample: 35 completed interviews

Figure 1. Consort chart.

VA's policy of routine screening for TBI in veterans of the war in Iraq (Operation Iraqi Freedom; OIF) and Afghanistan (Operation Enduring Freedom; OEF). Most participants were OIF veterans, followed by OEF veterans and 10.5% had served in both wars. Three-quarters had suffered a mechanical TBI, the most common cause being vehicular accidents. More than half had experienced blast-related injuries and a third had experienced both blast and mechanical injuries. More than one-third had experienced more than four TBIs. During the study period (from time of consent to follow-up interview), approximately two-thirds had a PTSD diagnosis and more than half had a depressive disorder documented as active in the medical record. Approximately two-thirds reported pain, one-quarter tinnitus and one-fifth photosensitivity.

Baseline differences by group

To determine the effectiveness of randomization, the two groups were compared on baseline values of sociodemographic, military and injury-related characteristics, baseline values of outcome variables, depressed mood [56], five subscales of the SF36V [68], TBI severity, use of formal care and services [55] and quality of relationship with the family member [69]. Table VI presents the baseline comparisons. The two groups did not differ on any baseline variable.

Characteristics of the VIP

Among the 272 sessions conducted with veterans, 73.8% took place in homes and 24.4% on the telephone. Family members were invited to participate in six in-home intervention sessions and participated in a mean of 4.25 (SD = 1.53, range = 1–7) sessions, which was judged to be substantial participation. Table I presents examples of VIP strategies developed to address typical multi-domain problems posed by TBI.

Efficacy of the VIP

Community re-integration

Community re-integration showed an effect for the VIP intervention. Veterans who received VIP had higher community re-integration scores at follow-up than did control-condition veterans, adjusting for PTSD injury severity, years since injury, sex, depressive symptoms and baseline community re-integration score. The comorbidities were selected to control for conditions that could themselves affect the outcomes. Table VII presents mean community re-integration scores for intervention and control groups at baseline and at follow-up and results of the ANCOVA. Among the covariates, only baseline community re-integration scores were significantly associated with the outcomes ($p = 0.000$).

Table IV. Sociodemographic characteristics of veterans (n = 81).

	Mean (SD)/percentage
Age (mean/SD)	40.07 (13.01)
Gender (% male)	91.4%
Marital status (% married)	71.6%
Years married (mean/SD)	12.22 (10.17)
Financial well-being* (mean/SD)	1.57 (1.06)
Employed	34.6%
Education	
Less than high school degree	4.9
High school degree or GED	24.7
Some college	45.7
College degree	16.0
Postdoctoral degree	7.4
Race	
White	58.0
Black	35.8
Native American	1.2
Asian	1.2
No primary	1.2
Other	2.5
Hispanic/Latino	13.6
Relationship of family member to veteran	
Spouse/partner	72.8
Mother	14.8
Sister	3.7
Brother	1.2
Other	7.4

* Difficulty paying for basics like food; scale: 0 (not at all), 1 (not very), 2 (somewhat), 3 (very).

Table V. Characteristics of veterans: TBI severity, war cohort, source of TBI injuries, number of TBI-related events, comorbidity and major symptoms (n = 81).

	Percentage/Mean (SD)
mild	69.1
mild–moderate	11.1
moderate	11.1
moderate–severe	3.7
severe	4.9
War cohort*	
OIF (Iraq)	61.7
OEF (Afghanistan)	23.5
Both OIF and OEF	10.5
Desert Storm (Persian Gulf)	6.2
Vietnam War	7.4
Post-Vietnam War era	9.9
Stateside injury	4.9
Years since 1st TBI (mean/SD)	12.06 (11.44)
Years since most recent TBI (mean/SD)	9.99 (11.12)
Source of TBI injury*	
Blast	55.8
Mechanical	75.3
Struck/thrown against object	18.5
Fall	29.6
Vehicular	32.1
Sports	8.6
Equipment malfunction	2.5
Assault/hazing by fellow service members	2.6
Other	8.6
Both blast and mechanical	32.5
Number of TBI-related incidents	
1	29.6
2	16.0
3	6.2
4	4.9
More than 4	36.9
Unknown	6.2
PTSD Dx during study period	66.7
Depression during study period	
Diagnosis	61.1
Treatment	50.6
Frequency of TBI-related symptoms*	
Pain	71.4
Tinnitus	27.3
Photosensitivity	22.1

*Does not add to 100% because some were in more than one category.

Target outcomes

Difficulty managing veterans' most troubling TBI-related problems also showed a benefit for the VIP participants. Using the difficulty ratings ('How difficult is it to manage this problem?') from the three target outcomes, the MANCOVA on the difficulty ratings at follow-up showed a significant overall main effect for treatment. Results of the MANCOVAs for the target outcomes individually are shown in Table VII. The MANCOVA was adjusted for PTSD injury severity, years since injury, sex, depressive symptomatology and baseline values of the dependent variable. Only the baseline values of the target outcomes were associated with the follow-up scores (p = 0.000).

Patient competency in functioning

Mean scores for the overall PCRS and for three functional domains identified in the factor analysis were used as measures of functional competency. The ANCOVAs for these outcomes, computed separately, did not reveal significant effects of the VIP (Table VII). All ANCOVAs adjusted for PTSD, years since injury, sex and baseline values for the dependent variable. Among the covariates, only baseline values of the dependent variables were significantly associated with the outcomes (p = 0.000).

Acceptability of VIP

Of the 41 veterans randomized to VIP, 38 (92.7%) participated. Of these, the mean number of sessions in which veterans participated, out of a maximum of 8, was 7.24 (SD = 1.92, range = 1–8). Mean responses on the Acceptability scale, ranging from 0–4, completed by the interventionists after the final session, was 2.94 (SD = 0.63), on which the highest possible score was 4.00. In addition, when asked at the conclusion of the study whether they would be willing to participate in another study on the same topic, 88.7% answered in the affirmative.

Discussion and conclusion

The VIP intervention demonstrated benefits for veterans with TBI in most predicted outcomes. Compared to controls, veterans in the VIP condition showed higher community reintegration scores and less difficulty managing their self-identified TBI-related problems. Effect sizes argue for the clinical significance of these findings.

Table VI. Baseline (T1) differences in sociodemographic characteristics and baseline values of outcome variables (*n* = 81).

Variable	Intx Mean (SD)	Intx %	Control Mean (SD)	Control %	*t* (df)	Chi-square (df)	*p*	Mean difference
Age	40.34 (12.46)		39.80 (13.70)		0.186 (79)		0.853	–0.541
Gender (% male)		87.8		95.0		1.33 (1)	0.249	
Years of education*	3.85 (1.085)		4.0 (0.93)		0.650 (79)			0.146
Years with partner	12.32 (9.93)		12.10 (10.60)		0.083 (58)		0.934	–0.219
Children (% with children)		78.0		75.0		0.105 (1)	0.746	
# children	2.79 (1.90)		2.34 (1.56)		0.67 (79)		0.503	–0.172
# children at home	1.12 (1.05)		0.95 (1.24)		1.048 (64)		0.299	–0.450
Employment (% employed)		29.3		40.0		1.03 (1)	0.310	
Financial difficulty	1.71 (1.00)		1.43 (1.11)		1.202 (79)		0.233	–0.282
Race		39.0		45.0		0.297 (1)	0.586	
Hispanic origin			7.3	20.0		2.775 (1)	0.096	
Community re-integration	0.020 (0.485)		–0.05 (0.38)		0.692 (79)		0.491	–0.067
Target Outcomes: Difficulty managing 3 worst problems	3.05 (0.67)		3.09 (0.79)		0.264 (79)		0.793	0.162
PCRS total	3.20 (0.54)		3.33 (0.59)		1.093 (79)		0.278	0.137
PCRS Interpersonal/ social	3.08 (0.61)		3.15 (0.72)		0.484 (79)		0.630	0.072
PCRS cognitive	2.75 (0.58)		2.82 (0.65)		0.469 (79)		0.641	0.064
PCRS IADL	3.78 (0.68)		4.07 (0.63)		1.993 (79)		0.050	0.291
CES-D score	19.51 (5.25)		17.73 (6.80)		1.325 (79)		0.189	–1.787
Quality of relationship	3.08 (0.053)		3.07 (0.51)		–0.049 (79)		0.961	–0.006
Time since last TBI	9.98 (11.09)		9.48 (11.15)		–0.403 (79)		0.688	–1.00
War cohort (OIF/OEF vs other)		75.6		72.5		0.102 (1)	0.749	
Severity of injury (% mild)		70.0		68.3	0.028 (1)		0.868	
PTSD Dx		65.9		67.5		0.025 (1)	0.875	
Depression Dx by VA		66.7		55.3		1.052 (1)	0.305	
Tx for depression		59.0		48.6		0.815 (1)	0.367	
Tinnitus		30.0		24.3		0.312 (1)	0.576	
Pain		75.0		67.6		0.520 (1)	0.471	
Photosensitivity		22.5		21.6		0.009 (1)	0.926	

*1 = < high school; 2 = some high school; 3 = high school diploma/GED; 4 = some college; 5 = college degree; 6 = post-graduate degree.

The VIP was highly acceptable to veterans. Scores on the Acceptability scales were high, as were the percentages of those willing to participate in a future study. In addition, the mean number of sessions in which veterans participated was quite high, 7.24 of a possible 8 sessions. This also supports veterans' strong engagement in VIP.

A notable innovative aspect of the study was its use of target outcomes. Because the brain controls behaviour, cognition, functioning and affect, brain injury can produce a wide range of symptoms and types of losses. This makes it especially difficult to select and use standard measures that capture a wide range of intervention effects. Target outcomes were found to be sensitive to change, arguing for their inclusion in future TBI intervention research. These targeted outcomes, reflecting the most meaningful problems for patients, also represent patient-centred outcomes, which are increasingly emphasized in outcomes research [67,70].

Of note was the complex and multi-dimensional nature of the TBI-related problems that veterans identified (see Table I). These inter-related cognitive, emotional, interpersonal and physical problems demand a more holistic approach that begins with the complex problem in its natural setting. Rehabilitation in the typical clinical setting focusing on more narrowly defined areas (e.g. memory) may be less efficacious and less translatable to the real world, where multi-dimensional TBI problems occur. This highlights the importance of occupational therapy, especially when practiced in a home setting and with family engagement. An optimal approach might combine VIP's focus on naturally complex everyday problems with an intensive structured cognitive rehabilitation programme [21,24].

Only functional ratings in the Patient Competency Rating Scale (PCRS) did not show an intervention effect. Several interpretations of these negative findings are possible. VIP was strongly patient-centred and focused on the outcomes identified by veterans, not on broad domains of functioning. The Action Plan contents did not closely map onto the three domains of functioning identified in the principal components analysis. A second possibility is that the PCRS, which has been used mostly with moderate-to-severe TBI samples, may be insufficiently sensitive to change in a primarily mild TBI sample. In addition, many PCRS items may have assessed too basic a level of functioning. VIP was not designed to alter basic functioning, but to provide strategies to attain identified goals of everyday activity—e.g. the focus was not to improve memory but to compensate for the effects of poor memory. The PCRS may not capture effects of this problem-solving and compensation-based intervention or the impact of adaptive strategies used to compensate for functional limitations. The fact that VIP had benefits for community re-integration and target outcomes but not functioning items suggests this. Future research should solicit veterans' use of adaptive strategies.

Study limitations and directions for future research

The sample was limited to veterans diagnosed and offered services within a VA medical rehabilitation service.

Table VII. Intervention effects: Results of analyses of covariance, controlling for sex, time since most recent TBI, PTSD diagnosis TBI severity, CES-D score and baseline values of each dependent variable.

Outcome	Tx, mean (SD)	Control, mean (SD)	*F* (df)	*p*	Cohen's d	95% CI
Community re-integration	0.10 (0.380)	–0.09 (0.50)	6.291 (1,64)	0.015	0.68	–0.428, –0.049
Target outcomes (MANCOVA)	2.56 (0.79)	3.03 (0.64)	3.552 (3,58)	0.020	0.66	0.183, 1.085
Overall functioning	3.33 (0.51)	3.37 (0.62)	0.284 (1,64)	0.349	0.20	–0.313, 0.181
Cognitive functioning	3.14 (0.56)	3.13 (0.83)	0.186 (1,64)	0.668	0.01	–0.40, 0.258
Emotional/interpersonal functioning	3.15 (0.78)	3.14 (0.77)	0.049 (1,64)	0.825	0.01	–0.357, 0.285
Physical functioning	3.93 (0.64)	3.98 (0.62)	2.228 (1,64)	0.140	0.01	–0.408, 0.059

Because only 58% of eligible veterans use VA care [1], findings may not be generalizable to those who do not access VA healthcare or to civilians with TBI. A related point concerns the fact that many persons with mTBI do not experience persistent symptoms. Study findings should be generalizable to the population with mTBI who *are* having troubling and lasting problems, as recent research has shown in some with mTBI [8,9].

Another caveat concerns the brief measure of community re-integration, which was derived from the original CRIS instrument and restricted to extent of participation, excluding daily functioning or satisfaction with participation, as represented in some community re-integration measures. Shorter versions of the CRIS [71] became available after initiation of this study and there was no widely accepted 'gold standard' for measuring veterans' community re-integration at the study inception [59]. However, the fact that extent of participation showed an intervention effect, whereas functional competence (as measured by the PCRS) did not, argues that these are distinct and dissociable constructs. If community re-integration is operationally defined too broadly, the impact of an intervention may be difficult to detect and interpret.

Another limitation was that the study did not include follow-up beyond 4 months. Future research should examine whether effects were maintained and whether veterans were able to continue to generalize strategies learned.

Potential impact

Study findings support for the viability of an in-home service for veterans with TBI. Because VIP is designed to augment and extend current clinical care, it adds to the clinical tools available to the VA health system and may be applicable to healthcare for civilian TBI as well. The VIP was very acceptable to veterans in this study, and the delivery of VIP within the home increased access to care for veterans with TBI and facilitated family participation. Because most family members cannot conveniently attend daytime clinic appointments with their veterans, an in-home service facilitates family involvement in the veteran's care. Family involvement is doubly useful in TBI rehabilitation because it both supports treatment adherence and maintenance and provides education and support to the family. Both these areas are highest priority within the VA health system [31].

Notably, neither severity of TBI nor time since most recent injury, despite their wide range in the sample, was significantly associated with any outcome variable. This suggests that even TBIs of long standing can pose enduring problems and may benefit from the VIP approach to intervention. The window of opportunity for effective intervention is, therefore, very wide.

With replication in a larger study with veterans and civilians with TBI, the VIP has the potential to benefit civilians who sustain TBI as well as the numerous veterans with service-related TBI. Hence, the communities that may benefit from this approach to intervention include veterans and their families and the millions of civilians who suffer sequelae from TBI as a result of falls, vehicular accidents, assaults and other events. For all of these groups, the potential impact of an intervention that improves community re-integration and help patients manage their TBI symptoms is enormous.

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Declaration of interest

The content is solely the responsibility of the authors and does not necessarily represent the official views of the Eunice Kennedy Shriver National Institute of Child Health & Human Development, the National institutes of Health, the position or policy of the Department of Veterans Affairs, or the United States government.

References

1. Defense and Veterans Brain Injury Center. DOD worldwide numbers for TBI. [Internet]. Silver Spring, MD: Defense and Veteran Brain Injury Center; 2014. [cited 3 Sept 2014]. Available from http://:www.dvbic.dcoe/dod-worldwide-numbers-tbi.
2. Hoge CW, McGurk D, Thomas JL, Cox AL, Engel, CC, Castro CA. Mild traumatic brain injury in U.S. soldiers returning from Iraq. New England Journal of Medicine 2008;358:453–463.
3. Kim EC, Lauterbach A, Reeve DB, Arciniegas KL, Coburn MF, Mendez TA, Rumman TA, Coffee EC, ANPA Committee on Research. Neuropsychiatric complications of traumatic brain injury: a critical review of the literature (A Report by the ANPA Committee on Research). Journal of Neuropsychiatry & Clinical Neuroscience 2007;19:06–127.
4. Sayer NA, Chiros CE, Sigford B, Scott S, Clothier B, Pickett T, Lew HL. Characteristics and rehabilitation outcomes among patients with blast and other injuries sustained during the Global War on Terror. Arch Phys Med Rehab, 2008;89:163–170.
5. Rao V, Lyketsos C. Neuropsychiatric sequelae of traumatic brain injury. Psychosomatics 2000;41:95–103.
6. Sayer NA, Chiros CE, Sigford B, Scott S, Clotherie B, Pickett T, Lew HL. Characteristics and rehabilitation outcomes among

patients with blast and other injuries sustained during the Global War on Terror. Archives of Physical Medicine & Rehabilitation 2008;89:163–170.

7. Schneiderman AI, Braver ER, Kang HK. Understanding sequelae of injury mechanisms and mild traumatic brain injury incurred during the conflicts in Iraq and Afghanistan: persistent postconcussive symptoms and posttraumatic stress disorder. American Journal of Epidemiology 2008;16:1446–1452.
8. Elder GA, Mitsis EM, Ahlers ST, Cristian A. Blast-induced mild traumatic brain injury. Psychiatric Clinics of North America 2010;33:757–781.
9. Zasler ND, Martelli MF. Mild traumatic brain injury: impairment and disability assessment caveats. Neuropsychological Rehabilitation 2003;13:31–41.
10. Cifu DX, Cohen SI, Lew HL, Jaffee M, Sigford B. The history and evolution of traumatic brain injury rehabilitation in military service members and veterans. American Journal of Physical Medicine & Rehabilitation 2010;90:688–894.
11. Centers for Disease Control. Traumatic brain injury [Internet]. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2014 [cited 4 Sept 2014]. Available from http://:www.cdc.gov/TraumaticBrainInjury/data/index.html.
12. Comper P, Bisschop SM, Carnide N, Tricco A. A systematic review of treatments for mild traumatic brain injury. Brain Injury 2005;19:863–880.
13. Cooper DB, Bunner AE, Kennedy JE, Balldin V, Tate DF, Eapen BC, Jaramillo CA. Treatment of persistent post-concussive symptoms after mild traumatic brain injury: a systematic review of cognitive rehabilitation and behavioral health interventions in military service members and veterans. Brain Imaging and Behavior 2015;9:403–420.
14. Gordon WA, Zafonte R, Cicerone K, Cantor J, Brown M, Lombard L, Goldsmith R, Chandna R. Traumatic brain injury rehabilitation: state of the science. American Journal of Physical Medicine & Rehabilitation 2006;85:343–382.
15. Park HY, Maitra K, Martinez KM. The effect of occupation-based cognitive rehabilitation for traumatic brain injury: a meta-analysis of randomized controlled trials. Occupational Therapy International 2015;22:104–116.
16. Mittenberg W, Tremont G, Zielinski RE, Fichera S, Rayls KR. Cognitive-behavioral prevention of postconcussion syndrome. Archives of Clinical Neuropsychology 1996;11:139–145.
17. Backhaus SL, Ibarra SL, Klyce D, Trexler LD, Malec JF. Brain injury coping skills group: a preventative intervention for patients with brain injury and their caregivers. Archives of Physical Medicine & Rehabilitation 2010;91:840–848.
18. Vanderploeg RD, Schwab K, Walker WC, Fraser JA, Sigford BJ, Date ES, Scott SG, Curtiss G, Salazar AM, Warden DL, Defense and Veterans Brain Injury Center Study Group. Rehabilitation of traumatic brain injury in active duty military personnel and veterans: Defense and Veterans Brain Injury Center randomized controlled trial of two rehabilitation approaches. Archives of Physical Medicine & Rehabilitation 2008;89:2227–2238.
19. Bovend'Eerdt TJ, Dawes H, Sackley C, Izada H, Wade DT. An integrated motor imagery program to improve functional task performance in neurorehabilitation: a single-blind randomized controlled trial. Archives of Physical Medicine & Rehabilitation 2010;91:939–946.
20. Pace GM, Schlund MW, Hazard-Haupt T, Christensen JR, Lashno M, McIver J, Peterson K, Morgan KA. characteristics and outcomes of a home and community-based neurorehabilitation programme. Brain Injury 1999;13:535–546.
21. Cicerone KD, Azulay J, Trott C. Methodological quality of research on cognitive rehabilitation after traumatic brain injury. Archives of Physical Medicine & Rehabilitation 2009:90:S52–S59.
22. Berg IJ, Koning-Haanstra M, Deelman BG. Long-term effects of memory rehabilitation: a controlled study. Neuropsychological Rehabilitation 1991;1:97–111.
23. Milders MV, Berg IJ, Deelman BG. Four-year follow-up of a controlled memory training study in closed head injured patients. Neuropsychological Rehabilitation 1995;3:223–238.
24. Kaschel R, Della Sala SD, Cantagallo A, Fahlbock A, Laaksonen R, Kazen M. Imagery mnemonics for the rehabilitation of memory: A randomized group controlled trial. Neuropsychological Rehabilitation 2002;12:127–153.
25. Cicerone KD, Mott T, Azulay J, Friel JC. Community integration and satisfaction with functioning after intensive cognitive rehabilitation for traumatic brain injury. Archives of Physical Medicine & Rehabilitation 2004;85:943–950.
26. Cicerone KD, Mott T, Azulay J, Sharlow-Galella MA, Ellmo WJ, Paradise S, Friel JC. A randomized controlled trial of holistic neuropsychological rehabilitation after traumatic brain injury. Archives of Physical Medicine & Rehabilitation 2008;89:2239–2249.
27. Sarajuuri JM, Kaipio ML, Koskinen, SK, Niemela MR, Servo AR, Vilkki JS. Outcome of a comprehensive neurorehabilitation program for patients with traumatic brain injury. Archives of Physical Medicine & Rehabilitation 2005;86:2296–2302.
28. Kreutzer JS, Stejskal TM, Ketchum JM, Marwitz JH, Taylor LA, Menzel JC. A preliminary investigation of the brain injury family intervention: impact on family members. Brain Injury 2009;23:535–547.
29. Bayley MT, Tate R, Douglas JM, Turkstra LS, Ponsford J, Sterfiou-Kita M, Kua A, Bragge P, INCOG Expert Panel. INCOG guidelines for cognitive rehabilitation following traumatic brain injury: methods and overview. Journal of Head Trauma & Rehabilitation 2014;29:290–306.
30. Davis T, Ings A. Head injury: triage, assessment, investigation and early management of head injury in children, young people and adults (NICE guideline CG 176). Archives of Disease in Childhood; Education & Practice Edition 2015;100:97–100.
31. Levin HS, Diaz-Arrastia RR. Diagnosis, prognosis, and clinical management of mild traumatic brain injury. Lancet: Neurology 2015;14:506–517.
32. Marshall S, Bayley M, McCullagh S, Velikonja D, Berrigan L, Ouchterlony D, Weegar K. Updated clinical practice guidelines for concussion/mild traumatic brain injury and persistent symptoms. Brain Injury 2015;2:688–700.
33. McCulloch KL, Goldman S, Lowe, L, Radomski MV, Reynolds J, Shapiro R, West TA. Development and clinical recommendations for progressive return to activity after military mild traumatic brain injury: guidance for rehabilitation providers. Journal of Head Trauma Rehabilitation 2015;30:56–67.
34. Boschen K, Gargaro J, Gan C, Gerber G, Brandys C. Family interventions after acquired brain injury and other chronic conditions: a critical appraisal of the quality of the evidence. NeuroRehabilitation 2007;22:19–41.
35. Verhaeghe S, Defloor T, Grypdonck M. Stress and coping among families of patients with traumatic brain injury: a review of the literature. Journal of Clinical Nursing 2005;14:1004–1012.
36. Ergh TC, Rapport, LJ, Coleman RE, Hanks RA. Predictors of caregiver and family Functioning following traumatic brain injury: social support moderates caregiver distress. Journal of Head Trauma Rehabilitation 2002;17:155–174.
37. Florian V, Katz S, Lahav V. Impact of traumatic brain damage on family dynamics and functioning: a review. International Disability Studies 1989;13:150–157.
38. Kreutzer JS, Marwitz JH, Kepler K. Traumatic brain injury: family response and outcome. Traumatic brain injury. Archives of Physical Medicine & Rehabilitation 1992;73:771–778.
39. Lezak M. Brain damage is a family affair. Journal of Clinical & Experimental Neuropsychology 1988;10:111–123.
40. Oddy M, Herbert C. Intervention with families following brain injury: evidence-based practice. Neuropsychological Rehabilitation 2003;13:259–273.
41. Glynn SM. Family -centered care to promote successful community reintegration after war: It takes a nation. Clinical Child & Family Psychology Review 2013;15:410–414.
42. Stejskal TM. Removing barriers to rehabilitation: theory-based family intervention in community settings after brain injury. NeuroRehabilitation 2012;31:75–83.
43. Lewin K. Dynamic theory of personality. New York: McGraw Hill; 1935.
44. Lawton MP, Nahemow LE. Ecology and the aging process. In: Eisdorfer C, Lawton MP, editors. The psychology of adult development and aging. Washington, DC: American Psychology Association; 1973. p 619–674.
45. Lawton MP, Nahemow L. Environment and other determinants of well being in older people. Gerontologist 1983;23:349–357.
46. Gitlin LN, Winter L, Dennis M, Hodgson N, Hauck WW. Effects of a nonpharmacologic, bio-behavioral home-based intervention on

functional status and quality of life of patients with dementia and well-being of their caregivers: a randomized trial. Journal of the American Medical Association 2010;304:983–991.

47. Gitlin LM, Winter L, Dennis M., Hodgson N, Hauck WW. Targeting and managing behavioral symptoms in individuals with dementia: a randomized trial of a nonpharmacologic intervention. Journal of the American Geriatric Society 2010;58:1465–1474.
48. Gitlin LM, Winter L, Dennis M, Hodgson N, Hauck WW. Tailored activities to manage neuropsychiatric behaviors in persons with dementia and reduce caregiver burden: a randomized pilot study. Journal of the American Geriatric Society 2008;16:229–239.
49. Gitlin LN, Winter L, Corcoran M, Dennis MP, Schinfeld S, Hauck WW. Effects of the Home Environmental Skill-building Program on the caregiver-care recipient dyad: 6-month outcomes from the Philadelphia REACH Initiative. Gerontologist 2003;43:532–546.
50. Gitlin, LN, Winter L, Dennis M, Corcoran M, Schinfeld S, Hauck W. A randomized trial of a multi-component home intervention to reduce functional difficulties in older adults. Journal of the American Geriatric Society 2006;54:809–816.
51. Asher IE, editor. Occupational therapy assessment tools: an annotated index. 3rd ed. Bethesda, MD: AOTA Press; 2007.
52. Pollard D, Olin D. Allen's Cognitive Levels: meeting the challenges of client focused services. Monona, WI: SelectOne Rehab; 2005.
53. Roitman DM, Katz N. Predictive validity of the Large Allen Cognitive Levels Tests using the Allen Diagnostic Module in an aged, non-disabled population. Physical & Occupational Therapy in Geriatrics 1996;14:43–59.
54. Josman N. Reliability and validity of the Toglia Category Assessment Test. Canadian Journal of Occupational Therapy 1999;66:33–42.
55. Wisniewski SR, Belle SH, Coon DW, Marcus SM, Ory MG, Burgio LD, Burns R, Schulz R, REACH Investigators. The Resources for Enhancing Alzheimer's Caregiver Health (REACH): project design and baseline characteristics. 2004. Psychology & Aging 2003;18:375–384.
56. Andresen EM, Carter WB, Malmgren JA, Patrick DL. Screening for depression in older adults: evaluation of a short form of the CES-D. American Journal of Preventive Medicine 1994;10:77–84.
57. Sander AM, Clark A, Pappadis MR. What is community integration anyway? Defining meaning following traumatic brain injury. Journal of Head Trauma Rehabilitation 2010;25:121–127.
58. Blais A, Thompson MM, McCreary DR. The development and validation of the army post-deployment reintegration scale. Military Psychology 2009;21:365–386.
59. Resnick L, Gray M, Borgia M Measurement of community reintegration in sample of severely wounded service members. Journal of Rehabilitation Research & Development 2011;48:89–102.
60. Sayer NA, Frazier P, Orazem RJ, Murdoch M, Gravely A, Carlson KF, Hintz S, Noorbaloochi S. Military to civilian questionnaire: a measure of postdeployment Community reintegration difficulty among veterans using Department of Veterans Affairs. Medical Care 2011;24:660–670.
61. Salter K, Foley N, Jutai J, Bayley M, Teasell R. Assessment of community integration following traumatic brain injury. Brain Injury 2008;22:820–835.
62. Resnik L, Plow M, Jette A. Development of CRIS: measure of community reintegration of injured service members. Journal of Rehabilitation Research and Development 2009;46:469–480.
63. Brown M, Dijkers MP, Gordon WA, Ashman T, Charatz H, Cheng Z. Participation objective, participation subjective: a measure of participation combining outsider and insider perspectives. Journal of Head Trauma Rehabilitation 2004;46:469–481.
64. Prigatano GP, Fordyce DJ, Zeiner HK, Roueche JR, Pepping M, Wood BC. Neuropsychological rehabilitation after brain injury. Baltimore, MD: Johns Hopkins University Press; 1986.
65. Prigatano GP. Disturbances of self-awareness and rehabilitation of patients with traumatic brain injury: a 20-year perspective. Journal of Head Trauma Rehabilitation 2005;20:19–29.
66. Sveen U, Roe C, Sandvik L, Bautz-Holter E. Self-rated competency in activities predicts functioning and participation one year after traumatic brain injury. Clinical Rehabilitation 2008;22:45–55.
67. Battle CC, Imber SD, Hoehn-Saric R, Nash ER, Frank JD. Target complaints as criteria of improvement. American Journal of Psychotherapy 1966;20:184–192.
68. Kazis LE. The Veterans SF-36 Health Status Questionnaire: development and application in the Veterans Health Administration. Medical Outcomes Monitor 2000;5:1–17.
69. Williamson GM, Shaffer DR, Schulz R. Activity restriction and prior relationship history as contributors to mental health outcomes among middle-aged and older spousal caregivers. Health Psychology 1998;17:152–162.
70. [Internet] Patient centered outcomes research. [cited 5 November 2015]. Available from: http://www.pcori.org.
71. Resnik L, Borgia M, Ni P, Pirraglia PA, Jette A. Reliability, validity and administrative burden of the community reintegration of injured service members computer adaptive test (CRIS-CAT). BMC Medical Research Methodology 2012;12:145.

Appendix A

To determine TBI severity, a study co-investigator with expertise in rehabilitation medicine reviewed the subject's electronic medical record and determined the subject's severity level using the VA/DOD Clinical Guidelines for Management of Concussion/Mild Traumatic Brain Injury (mTBI) (The Management of Concussion/mTBI Working Group, 2009). According to these guidelines, TBI injury severity is stratified across three levels (mild, moderate, severe) using five variables: reported findings on structural imaging based on radiographic reports; reported or documented length of time of loss of consciousness; reported or documented length of time of alteration of consciousness; reported or documented length of time of post-traumatic amnesia; and the Glasgow Coma Scale score at the time of the injury or injuries. For our study population, the Glasgow Coma Scales scores were unavailable; however data for the other four variables were consistently available in the subjects' medical records. When three or four of the variables were reported or documented as falling within the specified severity level, then this level was assigned (mild/moderate/severe); if one or two variables fell across two or three specified severity levels, then the level was assigned as "transitional" in severity (mild to moderate; moderate to severe). Thus, the sample population is described across five levels of severity: mild; mild-moderate; moderate; moderate-severe; severe. Although this approach is not usually taken during clinical TBI severity assignment when applying these guidelines, it did provide a more refined description of severity stratification for the present study.

Appendix B Brief Community Reintegration Scale

Instructions: I will ask you questions about how often you did or experienced certain things in the past two weeks. For this set of questions we are going to use this scale. On the left side of the scale is more than once per day. On the right side is never (you never did the activity). If you don't know the answer or prefer not answer, you can let me know. You can also say "Not applicable." Please remember to focus on your activities in the past 2 weeks.

1. On average, how often did you participate in recreational activities, *not* including watching TV?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	−2	*−3*

2. How often did you engage in hobbies?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	−2	*−3*

If veteran has children

3. How often did you spend quality time with your children?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	−2	*−3*

4. How often were you in contact with your family? (other than spouse, significant other, or children).

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	−2	*−3*

5. How often did you get together with friends?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	−2	*−3*

6. How often did you get together, in person, with friends who are nonveterans?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	−2	*−3*

7. How often did you read or watch the local or world news?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	−2	*−3*

8. How often did you follow current events?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	−2	*−3*

9. How often did you go to crowded places?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	*−2*	*−3*

10. How often did you help friends, neighbors or relatives that did not live with you?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	*−2*	*−3*

11. How often did you **avoid** socializing with others?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	*−2*	*−3*

12. How often did you **avoid** going to crowded places such as the mall or community gathering?

Not at all	Rarely	Occasionally	Sometimes	Often	Very often	Always	*Don't know*	*Refused*	*NA*
0	1	2	3	4	5	6	*−1*	*−2*	*−3*

13. Do you have a close friend in whom you confide? No () 0 Yes () 1

14. Please choose the answer that best corresponds to your current work situation (during the past 2 weeks):

Full-time (>20 hours/week)	Part-time (≤ 20 hrs/week)	Not working, but actively looking for work	Not working, not looking for work	Not applicable
3 ()	2 ()	1 ()	0 ()	*−3 ()*

15. Please choose the answer that best corresponds to your current school or training program situation (during the past 2 weeks):

Full-time	Part-time	Not attending school or training program	Not applicable
3 ()	2 ()	1 ()	*−3 ()*